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ABSTRACT

The software cooperative described in this report was established to provide each of the member colleges of the Massachusetts Board of Regional Community Colleges (MBRCC) with a cost-effective computer-assisted records system. After a brief outline of the planning efforts undertaken by the MBRCC in developing and testing the software system, the report discusses the organizational development process involved in installing the system at each college with a minimum of operational disruption. Functional specifications of the system are then detailed, including: the provision of students' admissions, registration, financial aid, and grade records; the availability of on-line, real-time, and batch access modes; and the provision of word processing capabilities for repetitive letter writing. An outline follows of the hardware components and software packages that make up the total system. Finally, the report summarizes, from both the perspective of the colleges and the private consulting firm that worked with them, implications for institutions considering cooperative software arrangements. Among other items, this section considers the importance of administrative commitment, the training needs of computer staff, and the planning activities involved in submitting hardware bid specifications. (JP)

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THE MBRCC STUDENT RECORDS SYSTEM WORKS!

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I. INTRODUCTION

Developed for the Software Cooperative established by the Massachusetts Board of Regional Community Colleges by Arthur D. Little Systems, Inc., the system is now installed in two Massachusetts community colleges and a private, liberal arts college, Rockford College in Rockford, Illinois (McFadden and Rodgers, 1980). The idea of a "software cooperative" was originally recommended by a task force at North Shore Community College (Beverly, Massachusetts), appointed by the President to determine the computing needs and strategic alternative of the college. Five strategic options were identified (Clements and Rodgers, 1977). The North Shore staff recognized that the college could not afford to develop the software required to meet the needs identified. The Task Force recommended the formation of a "software cooperative." The concept has been accepted by about half of the other fifteen members of the Massachusetts Community College system. Technical support is provided by Arthur D. Little Systems, Inc., and the Data General Corporation is the common hardware vendor.

The sections below review the history and development of the Software Cooperative, the functional design and the architectural environment of the Student Records System, and the conclusions and the implications for data processing in American higher education which may be drawn from the Massachusetts Board of Regional Community Colleges (MBRCC) Software Cooperative.

II. HISTORY AND DEVELOPMENT

A. FORMATION OF MBRCC SOFTWARE COOPERATIVE

MBRCC has made every effort to develop and implement an efficient and cost-effective computer capacity for all fifteen member colleges. The objective is to provide each college with sufficient computing support to effectively and efficiently meet the identified academic and administrative computing needs of each of the fifteen colleges and the MBRCC. The history and development of the long-range plan and the Software Cooperative are explained by Asquino (1972), Farmer (1976), Clements and Rodgers (1977), Tagney (1978), Rodgers and Traicoff (1978 and 1979), Gauthier and Rodgers (1980), and McFadden and Rodgers (1980).

The Massachusetts community college's plan is based upon minicomputers. It was visionary for its time--since minicomputers are just now supporting the types of operating systems, program languages, file handling and accessing capabilities, and communications protocols (Data General, 1980) necessary to implement the plan as described in Toward A Plan of Action (Asquino, 1972). Since 1974 the Massachusetts community colleges have issued three Requests for Proposals to minicomputer equipment manufacturers. Bids resulting from the first two RFPs were not accepted pending further study. The third RFP, issued in 1977 and based on a study by Farmer (1976), resulted in the award of a MBRCC system-wide

contract for minicomputers to the Data General Corporation of Westboro, Massachusetts for the ECLIPSE series equipment. The MBRCC Software Cooperative was established on March 30, 1978, by vote of the MBRCC Presidents Council.

B. IMPLEMENTATION OF THE MBRCC SOFTWARE COOPERATIVE

A comprehensive plan was developed for the implementation of the MBRCC Software Cooperative. This plan is based upon the commitment to ensure adequate involvement of the intended users of the MBRCC Student Records System in the priority establishment, design, and implementation processes based upon the following four major phases;

- Phase I: Prepare Strategic Information System Plan;
- Phase II: Develop System Design;
- Phase III: Develop and Test Application; and
- Phase IV: Install Application at Each Member College.

Phases I and II, and Phase III are now completed. Warranty and acceptance testing under a Phase IV Installation Agreement is also completed. This section reviews the progress to date in implementing Phase IV of the MBRCC Software Cooperative. The activities of Phases I, II, and III were reported by Rodgers and Traicoff (1978 and 1979), Gauthier and Rodgers (1980), Bear (1979), and Arthur D. Little Systems and Opinion Research Corporation (1978), and Arthur D. Little Systems (1979 A and B).

C. PHASE IV--INSTALLATION OF APPLICATION SOFTWARE AT USER's SITE

During this phase, the application software will first be installed at Berkshire Community College in Pittsfield, Massachusetts. Acceptance and warranty testing was conducted between April and October, 1980. During this procedure, the Berkshire Community College performed the acceptance testing and warranty testing on behalf of the Massachusetts community colleges. Best professional efforts were exerted by Berkshire and ADLS staff during the testing period so that the full capabilities of the system would be tested similar to the environment in which the system will actually be used. A total of thirty-eight errors were discovered and corrected during the testing period at Berkshire. After completion of the testing, the system is now available for installation at other colleges. North Shore Community College began installation in June, 1980, and is now putting the system in production.

The ADLS installation service for installing the system is based upon an organizational development approach which includes the services to minimize the disruptive nature of installing a system of this scale at a college. The activities are identified in Figure 1 which include the following:

Stage of Implementation	Objectives	Implementation Tasks for SRS
Assessment	Initial evaluations of needs vs. expertise	Negotiate Installation Agreement
Entry	Development of collaborative working relationship Establishment of commitment levels Responsibilities delegated Priority setting Agreements established	Refine Educational Computing Priorities
Diagnosis	Data gathering Joint definition of organizational needs and likely responses	Review of Functional Specifications Conduct System Configuration Analysis
Planning	Formal goal setting Timetables set Alternative plans evaluated Choice made Evaluation criteria determined for later use	Advise on Procurement/Modification of Equipment Design Communications Network Determine Administrative Procedural changes Develop Database Generation/conversion plan Redesign Forms as required Design Security System Procure Data from External Sources Develop New Codes Develop Acceptance Testing and Training Plans Train Users of System Prepare User and Technical documentation Develop and Review Implementation Plan
Action	Implementation stage Education/Training Feedback on results Communication between and among responsible parties	Install Software Applications on college computer ADLS runs diagnostic tests Convert/generate databases Conduct acceptance testing of each module: - Admissions - Financial Aid - Registration - Registrar's Processing Make adjustments according to acceptance plan
Evaluation	Assessment of action in terms of evaluation criteria Diagnosis	Accept SRS Complete installation of new system End parallel operations of old system
Post-Installation	Maintenance of Software Institutional Mechanisms	Post-installation agreements Evaluate Implement Process

FIGURE 1

SCHEDULE OF IMPLEMENTATION SUPPORT IN MBRCC SOFTWARE COOPERATIVE

RODGERS, 1980

- Assessment
- Entry
- Diagnosis
- Planning
- Action
- Evaluation
- Post-installation

During the action stage, the acceptance testing is completed. At this time, the college is eligible to initiate a software subscription service for maintenance of the software or the college may elect to maintain the software on its own. This conversion schedule has been developed from the experience at North Shore in the use of the pilot registration system (Rodgers and Traicoff, 1979), and the installation at Berkshire and North Shore Community Colleges in 1980, and the consulting and research experience of ADLS staff (Rodgers, 1980).

III. FUNCTIONAL REQUIREMENTS AND ARCHITECTURAL ENVIRONMENT

A. FUNCTIONAL REQUIREMENTS

The Student Records System is a management tool for the planning, management, and evaluation of the academic program of each institution, individually, and the Massachusetts community college system as a whole. The Student Records System consists of a database and tools for building, maintaining, and reporting from the database. The design of the Student Records System and the software techniques and technologies employed are consistent with the expressed policy direction of preserving the institutional autonomy of each college which uses the system - recognition of the diversity of their educational and administrative philosophies - external reporting to MBRCC and other state and federal agencies. The various functions supported, including academic computing, are described below.

- Database

The database for the Student Records System includes the following areas:

- student records, including admissions, testing and counseling, registration, transcript, and degree audit information;
- curriculum - all approved courses and other learning experience, such as classes, laboratories, seminars, tutorials, as well as off-campus activities;

- facilities information related to assigning classroom space;
- faculty information related to appointments, and instructional time and effort; and
- financial information related to financial aid and student payroll authorization.

- On-Line, Real-Time, and Batch Access to the Database

On-line access permits the users to perform data entry, maintenance and inquiry functions by accessing appropriate data in the database. Batch access is also required. Real-time and batch processing modes are to be balanced in order to avoid a negative impact on system performance.

- Functional Applications

Figure 2 presents an overview of the functional design of the Student Records System.

- Flexible Report Generating Capability

The system software of the Student Records System includes a report-generating capacity to produce unique, one-time reports from the database.

- Transaction-Based System

All modules of the Student Records System are based on integrated, transaction processing. A transaction is a series of pre-determined tasks which are initiated upon the entry of specified data. These transactions are processed by the application software.

- Distributive System Environment

Distributive systems embrace a network of data processing and communication capabilities which localize the generation and maintenance of data throughout the organization at points where the organizational units have the authority and responsibility for the generation and maintenance of relevant data. The Student Records System is capable of operating in a distributive system environment.

- Word Processing

The system software of the Student Records System supports a word processing capability to produce repetitive and variable insert letters using data stored in the database with direct output to a typewriter-quality output device. The memory capacity and sort capabilities of the database are available to support word processing.

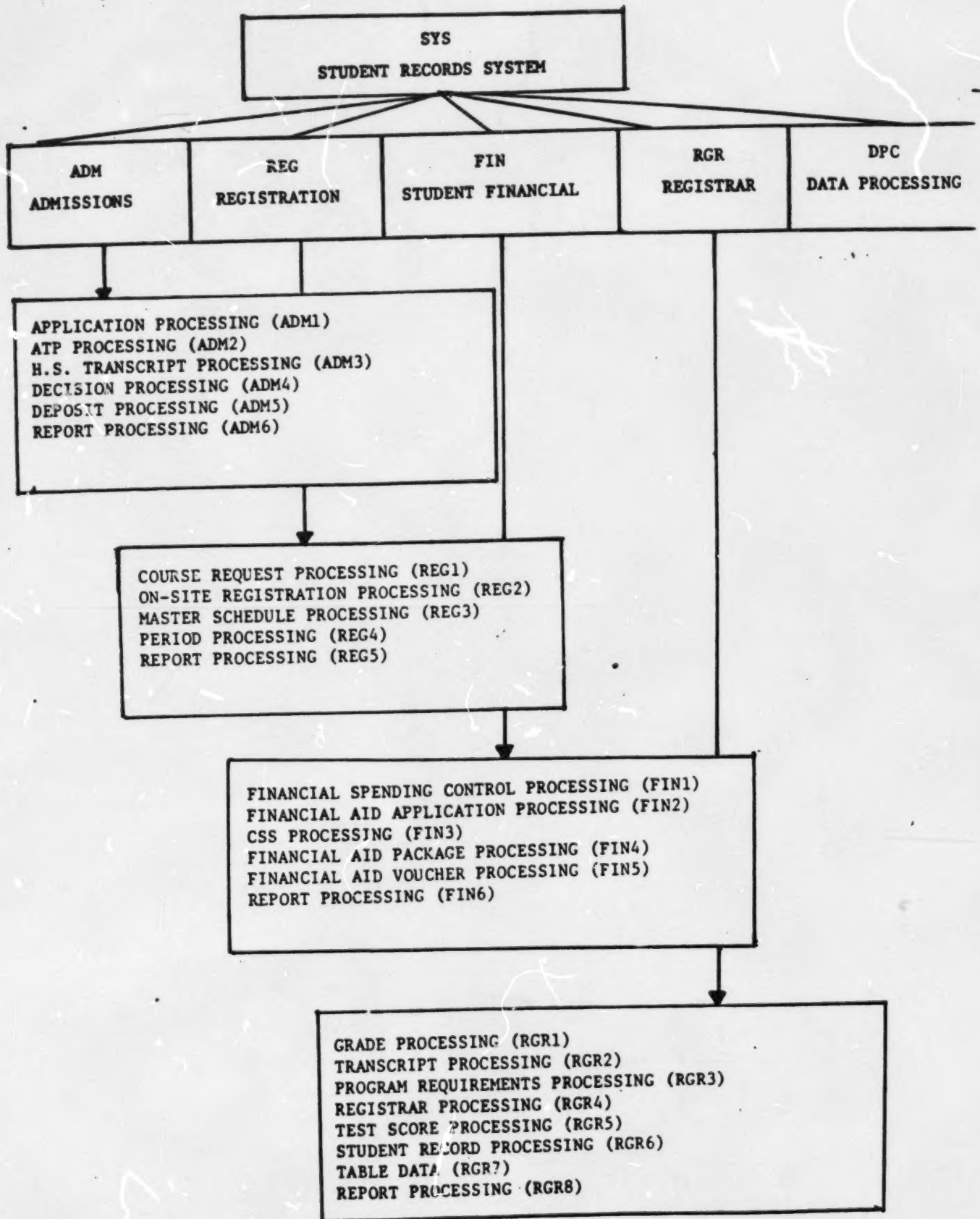


FIGURE 2 -- FUNCTIONAL SPECIFICATIONS OF THE STUDENT RECORDS SYSTEM

- Combined Academic and Administrative Processing

The Massachusetts community colleges have elected a strategy of combined academic and administrative processing on the same equipment. This strategy may be achieved within a reasonable performance expectation of the system (Bleiweiss and Gardner, 1980).

B. ARCHITECTURAL ENVIRONMENT

The architectural environment of the Student Records System is based upon the Data General ECLIPSE equipment (Data General, 1980). The environment may be summarized as below:

- The Data General ECLIPSE series equipment--the 16-bit machines (the C/150, C/330, C/350, and the M/600) as well as the new 32-bit product line, the MV/8000, may be utilized to support the Student Records System. An appropriate configuration is prepared based upon production and workload requirements of each college or university. Permit a brief summary of the base configuration developed by the Massachusetts community colleges. Note that the base configuration includes a half a megabyte CPU, two 96 megabyte disk drives, one dual density tape drive, and approximately 16 terminals. This base configuration was developed in 1978. In order to support current system software and academic computing, it is recommended that a 1.0-megabyte CPU be selected as opposed to .5-megabyte. However, the specific configuration requirements for an individual institution must be selected based upon their own workload requirements. The performance of the specific configurations are measured utilizing the performance model identified above. (Bleiweiss and Gardner, 1980).¹
- Operating System--the Student Records System operates under the Advanced Operating System (AOS), a multi-task, multi-processing operating system which supports time sharing, on-line, and batch processing. Many small colleges and universities will be utilizing the ECLIPSE equipment for both academic and administrative processing. Therefore, AOS was a main candidate for an operating system as opposed to the Real-time Disk Operating System (RDOS). The new operating system for the MV/8000, AOS/VS, has been announced. It will support the application software which has been developed under a 16-bit architecture machine and running under AOS (Data General, 1980).
- Program Language--the program language selected for a Student Records System is AOS COBOL, with the terminal management facilities of AOS COBOL. The language was selected because of its wide use and preference in administrative applications for colleges and universities. We have isolated the file handling components of the COBOL programs into file handlers so that upgrading of the file handling from INFOS to a database management system may be facilitated.

1) Note that the current recommended minimum equipment configuration for AOS and INFOS is 786 kilobytes.

- **File Handling and Access Capabilities**--the file handling tool which has been selected is INFOS, with INFOS QUERY. As mentioned above, the file handling components of application programs have been isolated so that upgrade to a database management system may be facilitated. In the future, we intend to upgrade the file handling capability to a database management system.
- **Word Processing**--the system architecture is designed to include a word processing capability which will utilize the sorting and record keeping capabilities of the Data General ECLIPSE computer with typewriter quality output. Colleges have a strong demand for repetitive letters, variable insert letters, and text preparation capabilities of word processing software. The AZ-TEXT software available from Data General and other products available from Data General OEM's are currently being analyzed for meeting the functional and technical requirements for word processing. To date, no member of the Software Cooperative has installed a word processing capability.
- **Communications**--in the future, it is expected that communications will be of more importance to the members of the Software Cooperative. The Data General software supports a full line of communications including remote job entry, as well as networking interfaces. As of this time, no college has used a communications capability (other than with modems) with the Student Records System. However, we have planned the architecture with the intention of colleges being able to use both RJE and network communication approaches.
- **High Level Reporting Language**--in order to meet the needs for ad hoc reports and query capabilities, a report generator and high level reporting language will be required. Currently, QUERY and REPORT WRITER are two available tools with INFOS to meet this requirement. In the future, utilizing the capabilities of a database management system, we expect to have enhanced capabilities for both query and ad hoc reporting. These features are one of the reasons why we are interested in upgrading the file handling capability to a DBMS.

IV. IMPLICATIONS FOR DATA PROCESSING IN AMERICAN HIGHER EDUCATION

The activities of the MBRCC Software Cooperative have been an important chapter in the history of data processing in American higher education. Among other things, the MBRCC Software Cooperative has demonstrated the practical utility and efficacy of sharing the development, implementation and maintenance of a complex, on-line system with several colleges. This project has made another strategic option available for colleges to consider in acquiring application software to meet the requirements, both strategically and operationally, for the 1980's. To some extent, the completion of the Software Cooperative efforts is similar to William Faulkner's short story, The Bear. If you are familiar with this story, you will recall the common bond of excitement and challenge which held together the diverse interest of the hunting party over its many years of searching for the cagey, crafty, and illusive bear. After the bear was caught, the party dispersed into their separate ways. Before the leadership of the Software Cooperative makes such dispersion, we would like to share with you the benefit of our experience so that others may not have to repeat the many mistakes which we made. Rest assured, you will make mistakes, but perhaps your mistakes can be new mistakes.

The Software Cooperative has been a unique undertaking for a group of colleges and a commercial organization. Below we summarize the perspectives and thoughts relative to the important conclusions resulting from this project both from the point of view of the participating colleges as well as the commercial service organization.

A. PERSPECTIVE OF THE PARTICIPATING COLLEGES

Based upon the experience of the leadership of the MBRCC Software Cooperative, the following advice will be made to other institutions which wish to consider installing cooperatively developed software applications:

- The President and his or her chief management team must be committed to the project, ready to support this effort, and prepared to lead the college into a major change which will undoubtedly be disruptive to the normal operating style of the institution;
- A trusted and respected employee of the college should be designated as Project Director, responsible for working closely with the software development team, the hardware manufacturer, and other institutions using the system. The Project Director must have the authority to develop and carry out an implementation plan and report progress to the President and/or his designee;
- An implementation plan, written clearly and concisely, must be agreed upon and assigned by all of the parties involved. This

plan should include at least the following:

- a comprehensive listing of the major steps, tasks, and procedures of the installation and a clear assignment of responsibility for each;
 - a carefully developed and detailed plan for conversion from the current system of the college to the new system;
 - a complete plan for user office staff training specifying the type of training, the hours and the trainer to be involved;
 - the designation of the software developer's staff who will be assigned to assist the college in designating a thorough test plan and be responsible to document or answer all problems that arise in the implementation of the testing processes;
 - a procedure for reporting problems discovered to the software development team and acknowledgement or resolution of those problems;
 - a warranty, or other assurance, of the software product and the conditions related to it;
 - a clear statement of what is not included in the installation; and
 - the cost of the installation;
- The members of the computer staff should be thoroughly trained and guided through each process of the system by a staff member of the software development team including:
 - how to install updates and revisions;
 - how to request batch jobs and reports;
 - how to back up the system and insure the necessary integrity of files for restart/recovery purposes;
 - An early review and resolution of operational software on the host computer must be performed by the applications software development team to ensure that the college's system software is maintained at the required revision and/or releases to accomodate the new system;
 - The President needs to be prepared to:
 - personally advocate, support, and define the project to a wide variety of populations, under a wide array of circumstances, and for a seemingly endless period of time;
 - deal with the rising expectations of faculty, administrators, staff, and students;
 - commit future resources to maintaining, modifying, and expanding the system to meet future requirements.

The above recommendations are based upon the experience of Berkshire Community College and North Shore Community College in implementing the MBRCC Student Records System.

B. PERSPECTIVE ON BEHALF OF THE COMMERCIAL SERVICE FIRM

From the perspective of Arthur D. Little Systems, this project has been both challenging and difficult. Its challenges have been in the areas of both the human dynamics and organizational issues involved in orchestrating and coordinating, mostly through leadership and persuasion as opposed to direct influence and responsibility, and the technological capabilities, as well as deficiencies and limitations, of currently available commercial minicomputer technologies. The multi-client dimension of the MBRCC Software Cooperative added a third significant and important aspect. These aspects lead to the four important conclusions for this project from our perspective:

- A service versus a product strategy;
- Governance and management procedure for identifying and resolving conflict;
- A long-time commitment to a common system architecture; and
- Decentralization of technical capacity.

Each of the four issues are discussed below:

The four year project plan described above was based upon a service strategy, as opposed to a product-based strategy, for developing, implementing and testing the Student Records System. The service strategy approach contributes more effectively to achieving broader goals of improving the governance and management of educational institutions through developing, implementing, and maintaining better administrative systems. we believe that the achievement of these broader objectives will result in the following benefits to the participating members of the Software Cooperative:

- An improvement of the data available for day-to-day administration, institutional policy in decision making, and external reporting and accountability;
- An improvement in the staff and administrative productivity of the colleges; and
- An improvement to the services provided to students.

Fundamental to the service approach is the linkage process which assists the members of the Software Cooperative in implementing their objectives and achieving these desired benefits. This approach is distinctive from other approaches, notably those based upon providing a finished product with little to no opportunity for the client to understand the product before its delivery. A major limitation of the product-based approach is its assumption of a quite inactive role on behalf of the client until such time as the finished product is delivered. Such an approach often leads to unnecessary dependency on the service firm by the client.

We believe that the service strategy utilized in our support to the MBRCC Software Cooperative results in correcting the following deficiencies of the product-based strategy:

- Lack of an explicit recognition of the organizational and interpersonal change involved in developing and implementing complex administrative applications and the likely consequences of such projects (including both desired and undesired consequences);
- The lack of a process that will simultaneously support the production and delivery of the system with respect to:
 - the service required so that the client (both user staff and technical staff) may understand and be able to use the products without undue dependency upon the external organization providing the products;
 - acceptance of the joint responsibility on behalf of the service firm and the client staff to achieve the objective of the project and reduce the risk and liabilities of both parties;
 - and an opportunity to share the knowledge and experience of the service firm's staff and the client's staff with respect to the multi-disciplinary requirements of a complex project of this nature;
- Documentation and evaluation are the benefits to be realized in converting to an on-line, databased oriented administrative system; and
- A management process, presented in the four phased project plan, which explicitly offers an opportunity for significant client participation to effectively manage the organizational change induced by converting to complex new administrative systems.

By correcting the above deficiencies of the product-based strategy, the overall cost (both human and financial) and the risk to the client system is reduced in achieving their objectives for the significant conversion involved. The same strategy leads to developing a final tangible product with the added assurance of the client's understanding of its functionality and technical aspects. For an extended discussion of the above distinction, see Rodgers and Rhodes (1978), and Rodgers (1978 and 1980).

The governance and management of a software cooperative effort is most important. One should begin with the idea that conflict is inherent in such an effort, and that the management of conflict resolution is as important as resolving the technical issues. There are many individuals who will be involved, each with their own aspirations, concerns, expectations, anxieties, and frustrations, as well as hopes and aspirations. Management of the conflict resolution process is a key executive management responsibility. We believe that there are several components of the conflict resolution process which should be considered, including:

- Leadership to support the resolution of conflict;

- Establish set of ground rules for making decisions and resolving conflict through an established or temporary organizational structure; and
- A decision network in which those individuals who will be affected by the new system have confidence that they can influence.

Resolution of conflict has been one of the major activities of the MBRCC Software Cooperative. Many issues have come up over the last four years. No issue has been identified which could not be resolved by reasonable parties coming to an understanding, and one which often required compromise on all parties involved. Many of the concepts utilized as basis for the MBRCC Software Cooperative design were taken from the work of Demb (1975), and Likert and Likert (1976) and Rodgers (1980).

To achieve the economies of scale available through sharing software development requires a long-term commitment to a common system architecture. This commitment for the Massachusetts community college Software Cooperative was achieved through a common bid for a hardware vendor to support all of the Massachusetts community colleges. Once a hardware vendor was selected, the appropriate architecture, matching the functional requirements with the technical capabilities, was elected by Arthur D. Little Systems in consultation with members of the Software Cooperative. In retrospect, ADLS would recommend that future institutions would carefully plan the system architecture prior to preparation for any hardware bid specifications. By committing to a long-term, system architecture, the participating institutions are preserving and protecting their investment in application software. Sharing a common software architecture is also essential to any ability to share the administrative applications between and among various colleges. While the ideal system engineering developments have been discussed for some time which would make application software transportable across various vendors, it is still quite difficult to achieve any practical and reasonable balance between functionality and performance of administrative applications across more than one system architecture. Until there are significant advances in system architecture, we do not believe that it would be practically feasible, to consider attempting to implement a Software Cooperative approach, without committing to a common system architecture.

The technical capability to support the cooperative effort should be decentralized to the member campuses, and not centralized in a central office or system office. It is important that the individual colleges have control and direction to the technical staff, and that the staff are directly accountable to the executive management of the colleges. Decentralization of the technical staff is one of the key reasons for the success of the MBRCC software cooperative, and merits consideration by other multi-campus systems considering development of common application software for their respective member institutions. Withington has made a similar suggestion in his recent article concerning decentralization of technical talent for divisionalized organizations (Withington, 1980).

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